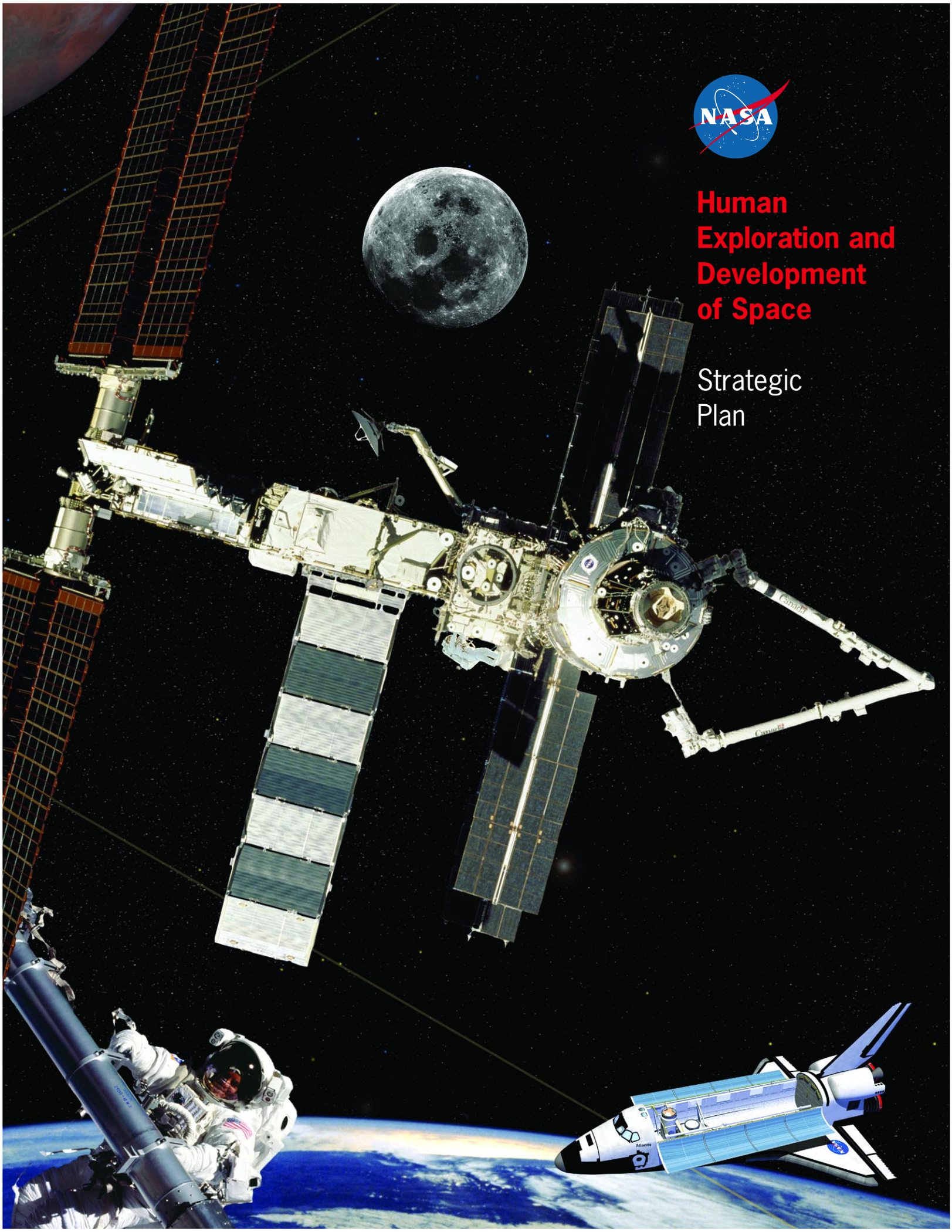


Human Exploration and Development of Space

Strategic Plan

Contents

The Four Human Exploration and Development of Space (HEDS) Goals

Explore the Space Frontier

Enable Humans to Live and Work Permanently in Space

Enable the Commercial Development of Space

Share the Experience and Benefits of Discovery

HEDS Strategic Plan 2000 revised August 2001

NASA Vision

NASA is an investment in America's future. As explorers, pioneers, and innovators, we boldly expand frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.

NASA Mission

To advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe

To advance human exploration, use, and development of space

To research, develop, verify, and transfer advanced aeronautics and space technologies

HEDS Mission

To expand the frontiers of space and knowledge by exploring, using, and enabling the development of space for human enterprise

Letter from the Associate Administrator

"The vision of our role in the new century is clear. NASA is an investment in America's future."

Joseph H. Rothenberg

Dear team members and stakeholders of the Human Exploration and Development of Space Enterprise:

As we enter a new millennium, people the world over are reflecting on the accomplishments of the past and speculating about opportunities of the future. Some of the most inspiring and important accomplishments of the past four decades have resulted from the space program: events such as the planet-wide impact of the Apollo landings on the Moon and images of the Earth; discoveries such as the astonishing Hubble Space Telescope photos of solar system formation; achievements such as the sending of the first human artifacts—Pioneer and Voyager spacecraft—beyond our solar system; new capabilities such as communications and weather satellites; and construction/operation of the first reusable launch vehicle—the Space Shuttle. Space has touched the lives of many hundreds of millions worldwide.

The vision of our role in the new century is clear: NASA is an investment in America's future. We will boldly expand the frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.

During the coming 25 years, we must achieve profound strategic goals in space. In supporting the realization of our vision, the mission of HEDS is to expand the frontiers of space and knowledge by exploring, using, and enabling the development of space for human enterprise.

It is in this context that we present this strategic plan for the HEDS Enterprise—a plan that we believe will enable us to achieve challenging technical feats with enormous societal benefits. Our goals are:

- Explore the space frontier
- Enable humans to live and work permanently in space
- Enable the commercial development of space
- Share the experience and benefits of discovery

We begin with the foundation of the Space Shuttle and the International Space Station, and continue to increase our capabilities through NASA's research and technology development programs—such as Space Launch Initiative, In-Space Propulsion program, New Millennium program, Advanced Human Support Technology Program, and HEDS focused technology programs.

We also aspire to make possible U.S. leadership of international efforts to extend permanently human presence beyond the bounds of Earth, involving both machines and humans as partners in innovative approaches to exploration. We will engage the private sector in the commercial development of space in order to enable the continuation of current space business and the creation of new wealth and new jobs for the U.S. economy—while laying a stronger foundation for future exploration.

Together we can accomplish these goals and enable historic improvements in our understanding of nature, in human accomplishment, and in the quality of life. This strategic plan for the Human Exploration and Development of Space Enterprise is the foundation upon which we build this future.

Joseph H. Rothenberg
Associate Administrator,
Office of Space Flight

The HEDS Challenge

In order to make possible the permanent extension of human presence beyond the bounds of Earth and enable historic improvements in the understanding of our solar system and the universe, and in the quality of life, NASA must:

- undertake international human/robotic expeditions throughout the inner solar system in partnership with the scientific community;
- facilitate breakthrough discoveries and technology developments through basic, applied, and commercial research in the unique venue of space-exploiting characteristics such as microgravity, vacuum, radiation, and location;
- establish safe, routine access to space to support both permanent commercial human operations in low-Earth orbit and ongoing exploration activities at one or more sites beyond low-Earth orbit;
- engage the private sector in the commercial development of space, enabling the creation of new space industries to benefit the U.S. economy; and
- communicate the importance, excitement, and benefits of space exploration and development.

In order to guide planning, the HEDS Enterprise has identified some potential future targets and goals (i.e., "Design Reference Points")—that begin in the near term and extend for the next quarter century and beyond.

Near-term Plans 2000–2005

Commercial Development, Space Shuttle 7- to 14-day mission duration, International Space Station 30- to 90-day missions

The HEDS Enterprise will continue to pursue privatization of Shuttle operations and invest in upgrades and improvements to ensure that the Shuttle provides safe and reliable human access to space until a replacement system is available. The Space Shuttle, the International Space Station and expendable launch vehicles will be the foundations for continuing the utilization and commercialization of Earth orbit. As the Space Station develops, NASA will open the facility aggressively to commercial use. NASA is encouraging entrepreneurs and scientists to identify opportunities to use the Station for "Pathfinder" projects to bring business concepts to reality.

At the same time, the HEDS Enterprise will partner with industry and other organizations to develop and demonstrate new technologies to enable future goals.

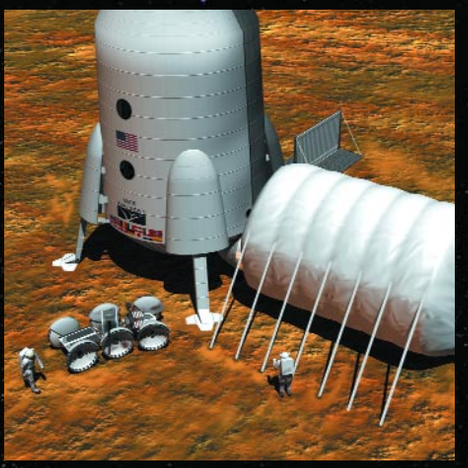
Mid-term Plans 2006–2011

Extending human reach beyond low-Earth orbit, 100-day mission duration

In the coming decade, we hope to set in place new capabilities that will enable the era of human exploration beyond low-Earth orbit—initiated during the Apollo program—to continue. These 100-day class capabilities could make possible missions to Earth-Moon and Earth-Sun "Libration Points" (points at which gravitational forces balance) where astronauts could maintain revolutionary new space-based telescopes and establish key exploration infrastructures.

Those capabilities would also allow further exploration of the lunar surface, expanding knowledge, and providing an experience base for reducing the cost and risk of subsequent exploration. Lunar missions could also answer questions about how we can use lunar resources commercially and sustain operations at other planetary venues.

Establishing space-based and lunar infrastructures will enable new opportunities for the commercial development of space—and hence, more ambitious exploration goals.



Long-term Plans 2012–2025

Extending human reach beyond Earth orbit, 500- to 1,000-day mission duration

Through space science mission payloads, HEDS mission designers will learn about the surface of Mars in preparation for integrated human/robotic missions to Mars early in this century.

In the region of space between Earth and Jupiter, there are tens of thousands of asteroids—some composed of valuable minerals, others of materials that could be used for propellants, in space construction, or commercial ventures. Improved HEDS capabilities could make possible future human/robotic missions to these challenging and scientifically interesting targets.

These and other longer-range missions contemplated for the far term may answer questions about the history of Mars and the possibility of past or present life there or elsewhere in the solar system.

Beyond

Mission duration, 2,000-day and longer

As technology advances, human destinations in the outer solar system, such as Ganymede, an ice-covered moon of Jupiter, and Titan, a moon of Saturn that has an atmosphere similar to that of ancient Earth—might become accessible to human missions later this century.

Although unlikely in the coming decades, eventually technology may open the way for major probes to the very edges of our solar system and beyond.

The Four HEDS Strategic Goals

The Four HEDS Strategic Goals

To transform the challenge into reality, NASA's Human Exploration and Development of Space (HEDS) Enterprise has set the following strategic goals:

- Explore the Space Frontier
- Enable Humans to Live and Work Permanently in Space
- Enable the Commercial Development of Space
- Share the Experience and Benefits of Discovery

This Strategic Plan explains why these goals are necessary and describes how HEDS intends to achieve them.

Caption:

Astronaut Robert Curbeam working near the Pressurized Mating Adapter on the International Space Station

Goal 1: Explore the Space Frontier

Earth orbit, the Moon, near-Earth space, Mars and the asteroids, eventually the moons of the giant planets of the outer solar system, and someday more distant worlds...

There are certain ideas that many believe to be inherent in the human psyche and integral to American culture: ambition for progress, curiosity about the unknown, the need to pose profound questions and to answer them, the concept of new frontiers that—once achieved—promise a better quality of life for all people. Space is such a frontier. Earth orbit, the Moon, near-Earth space, Mars and the asteroids, eventually the moons of the giant planets of the outer solar system, and someday more distant worlds—these are collectively the endless, ever-expanding frontier of the night sky under which the human species evolved and toward which the human spirit is inevitably drawn.

It is a fundamental goal of NASA to explore the space frontier progressively through human exploration, space-based scientific research, and commercial development.

Goal 1: Strategic Objectives

- Invest in the development of high-leverage technologies to enable safe, effective, and affordable human/robotic exploration.
- Conduct engineering research on the International Space Station to enable exploration beyond Earth orbit.
- Enable human exploration through collaborative robotic missions.
- Define innovative human exploration mission approaches.
- Develop exploration/commercial capabilities through private sector and international partnerships.

Captions:

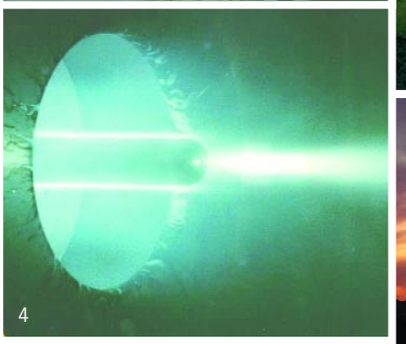
Human explorer on Mars

Left: Human/robotic exploration

Middle: Future lunar missions

Right: Human-serviced large space telescopes

Explore the Space Frontier—Time-Phased Objectives Roadmap

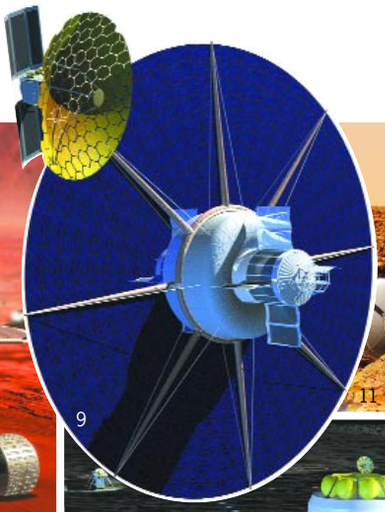


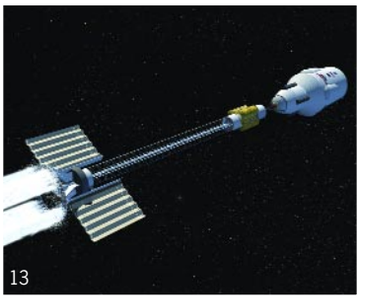
Captions:

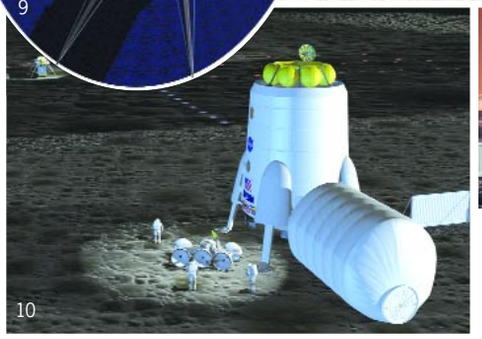
1 Mapping Martian surface, NASA Mars Odyssey
2 Space exploration using expendable launch vehicles
3 Research long-term effects of radiation in space on the International Space Station
4 Advanced propulsion testing
5 Advanced space suit technology
6 Communications architecture for NASA space research and exploration
7 Robotic exploration of Mars, 2003 NASA Mars Exploration Rover
8 Mobile science laboratory Mars mission, NASA's Smart Lander and Long-range Rover
9 L1 "Gateway" Station
10 Lunar outpost
11 Human/robotic Mars mission
12 Mars outpost
13 1000-day-capable human space exploration vehicle

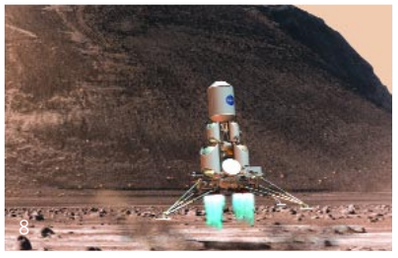
Near-term (2000–2005)

- Probe environments beyond low-Earth orbit in collaboration with the science community, obtaining data from robotic missions to aid design decisions for future safe, effective, and affordable human exploration.
- Use the International Space Station to test and validate countermeasures to physiological problems in long-term space flight.
- Identify and evaluate candidate approaches for 100- to 1,000-day human missions featuring an 80 to 90% cost reduction and increased safety and effectiveness (compared to 1990's projections).
- Identify with U.S. industry the commercial potential of candidate 100- to 1,000-day human mission concepts and technologies.
- Develop and test, on the ground and in space, competing technologies for human missions beyond low-Earth orbit in cooperation with other enterprises, agencies, international partners, and U.S. industries. Pursue jointly funded research and development when mutual objectives permit.
- Ensure that reliable, affordable U.S. communications services are available to meet the Nation's communications needs for science, exploration, and Earth-observing missions.
- Identify communications needs for future deep space missions and Earth-orbiting spacecraft. In collaboration with industry and other U.S. Government agencies, develop an integrated space communications architecture for use in robotic and human space flight missions over the next decade.
- Continue to advocate and help develop international space communications standards leading to interoperable communications facilities for international missions.









Mid-term (2006–2011)

- Collaboratively with the space science community, conduct robotic/engineering missions that establish continuing operations at key sites (i.e., "outposts") to
  - acquire data and validate technologies,
  - construct and validate infrastructure for later human expeditions, and
  - make possible unique science activities before the arrival of human explorers.
- Implement countermeasures for space radiation and microgravity to enable safe, affordable 1,000-day human missions.
- Facilitate privately funded industry development of key 100-day human mission capabilities and identify (jointly with industry) the commercial potential of—and technology research and development projects for—1,000-day and longer human missions.
- Develop the capability for affordable, 100-day class integrated human/robotic expeditions to a previously established "outpost" beyond low-Earth orbit in collaboration with international partners for scientific research and technology development.
- Refine existing approaches for 1,000-day missions; continue to identify and evaluate innovative new approaches for such missions yielding a 90 to 95% cost reduction compared to earlier projections. Continue to develop and validate competing breakthrough technologies for these cost reductions in cooperation with external partners, including U.S. industry.
- Integrate and advocate an overall communications architecture and promote infusion of new technologies.

Far-term (2012+)

- Complete the development of safe, self-sufficient, and self-sustaining systems that can enable humans to live and work in space and on other planets independent of Earth-provided logistics for extended periods.
- Pursue ambitious collaborative robotic/engineering missions that expand activities at existing and additional key sites (i.e., "outposts") beyond low-Earth orbit.
- Develop the capability for the first 1,000-day, highly integrated human/robotic expedition to a previously established site beyond low-Earth orbit (i.e., an "outpost") in collaboration with international partners to expand human knowledge and test technologies for the continuing extension of human activities and enterprise in space.
- Finalize candidate architectures and begin technology development to enable a further 50 to 75% reduction in costs for ambitious long-term human exploration objectives, making use of revolutionary technologies and both new and existing infrastructures.

Goal 2: Enable Humans to Live and Work Permanently in Space

Human presence will be an essential factor in successfully opening the space frontier and expanding knowledge through research in space.

Advances in technology notwithstanding, the human element continues to be a major factor in the success or failure of many terrestrial enterprises. Often, innovative technologies are most effective when used to leverage or enhance the productivity of humans. Moreover, the human element is a quintessential component in the public's continuing interest in and support for the space program.

Human presence will be a key factor in successfully opening the space frontier and expanding knowledge through research in space. It will be an increasing component of commercial space operations. By pioneering human presence in space, NASA opens the door to an array of benefits, tangible and intangible, for the people of the United States and the world.

It is, therefore, a goal of NASA to enable and establish permanent and productive human presence in space, to advance America's aspirations and opportunities in space through new technologies and new ways of doing business.

Goal 2: Strategic Objectives

- Provide and make use of safe, affordable, and improved access to space.
- Operate the International Space Station to advance science, exploration, engineering, and commerce.
- Ensure the health, safety, and performance of humans living and working in space.
- Meet sustained space operations needs while reducing costs.

Captions:

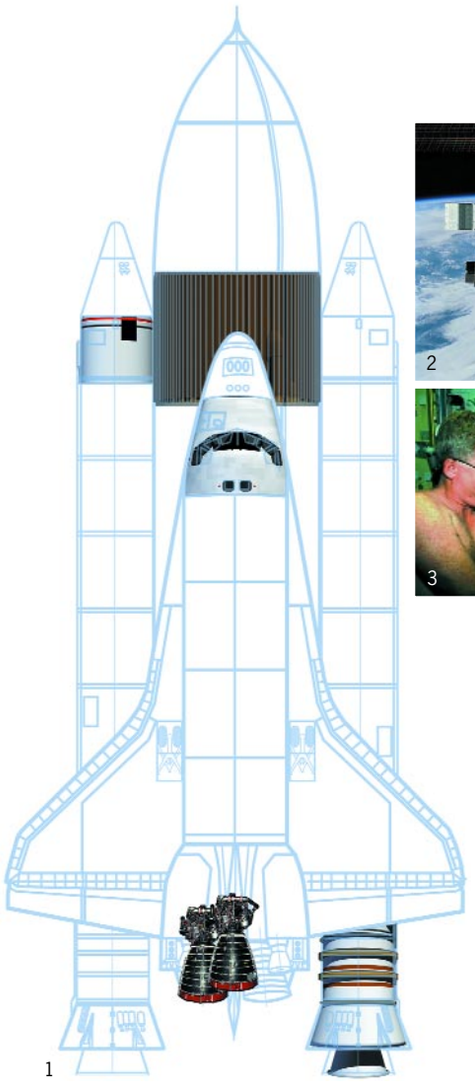
Expedition Two crewmembers—astronaut Susan Helms, cosmonaut Yury Usachev, and astronaut James Voss—in the U.S. Laboratory Destiny module of the International Space Station

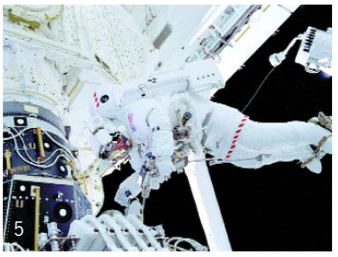
Left: Astronauts servicing the Hubble Space Telescope

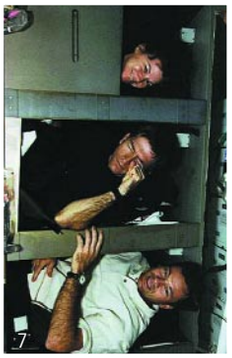
Middle: Spacewalking astronaut Jerry Ross conducting extravehicular activities

Right: Astronaut Mae Jemison performing the Autogenic Feedback Training Experiment inside the Spacelab science module

Enable Humans to Live and Work Permanently in Space—Time-Phased Objectives Roadmap







Near-term (2000–2005)

- Transition Space Shuttle operations to the Space Flight Operations Contractor and undertake needed Shuttle upgrades to increase safety and supportability.
- Complete development of the International Space Station, including international partner contributions, to enable a robust research program to begin.
- Pursue conversion of the International Space Station to a user-driven operation by creating a non-governmental organization to simplify the process for, and reduce the costs of, access to and operations in low-Earth orbit.
- Conduct exploration and engineering research on the Station—and enable in-space scientific and commercial research—to improve health, safety, and the quality of life on Earth.
- Partner within NASA and with industry to mature technologies needed for future HEDS space transportation. These include both vehicles and infrastructure, for both launch and in-space transportation.
- Partner with industry to validate technology to mitigate risk associated with privatization and/or commercialization of space communications systems and/or operations.
- Work with industry on scenarios, research and development plans, and in-space validation of competing technologies for 100-day human expeditions beyond low-Earth orbit. This includes enabling commercial communications services for mission communications.
- Design strategies to maintain health, safety, and performance in the hostile environment of space.
- Test and validate technologies and systems that can reduce the overall mass of human support systems by a factor of two (compared to 1990's levels).
- Conduct research in analog test beds and on orbit to enhance medical care in-space (during Space Shuttle, Space Station, and extravehicular (EVA) activities) and after return to gravity.
- Identify important science objectives for 100-day missions exploiting human presence, and begin technology research and development to expand science capabilities.
- Enable capability for routine and emergency cargo delivery to the International Space Station on U.S. launch systems.
- Develop and demonstrate advanced spaceport and range technologies that enable safer, more reliable, lower-cost access to space.

Captions:

1 Space Shuttle upgrades
2 International Space Station as of August 2001
3 Healthcare in space
4 & 5 Assembly of Space Station
6 Space Shuttle restroom
7 Sleeping quarters on the Space Station
8 Space communications satellite
9 Completed International Space Station
10 Permanent crews aboard the Space Station
11 Space optical communications
12 2nd generation reusable launch vehicle
13 Future spacecraft in-space assembly
14 Lunar human/robotic mission
15 Solar/electric space vehicle
16 Explorers return to Earth
17 Revolutionary launch vehicles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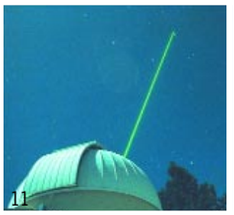
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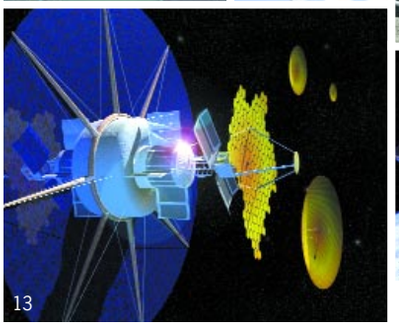
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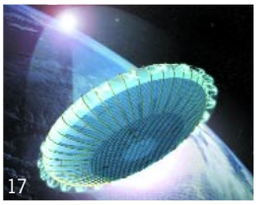
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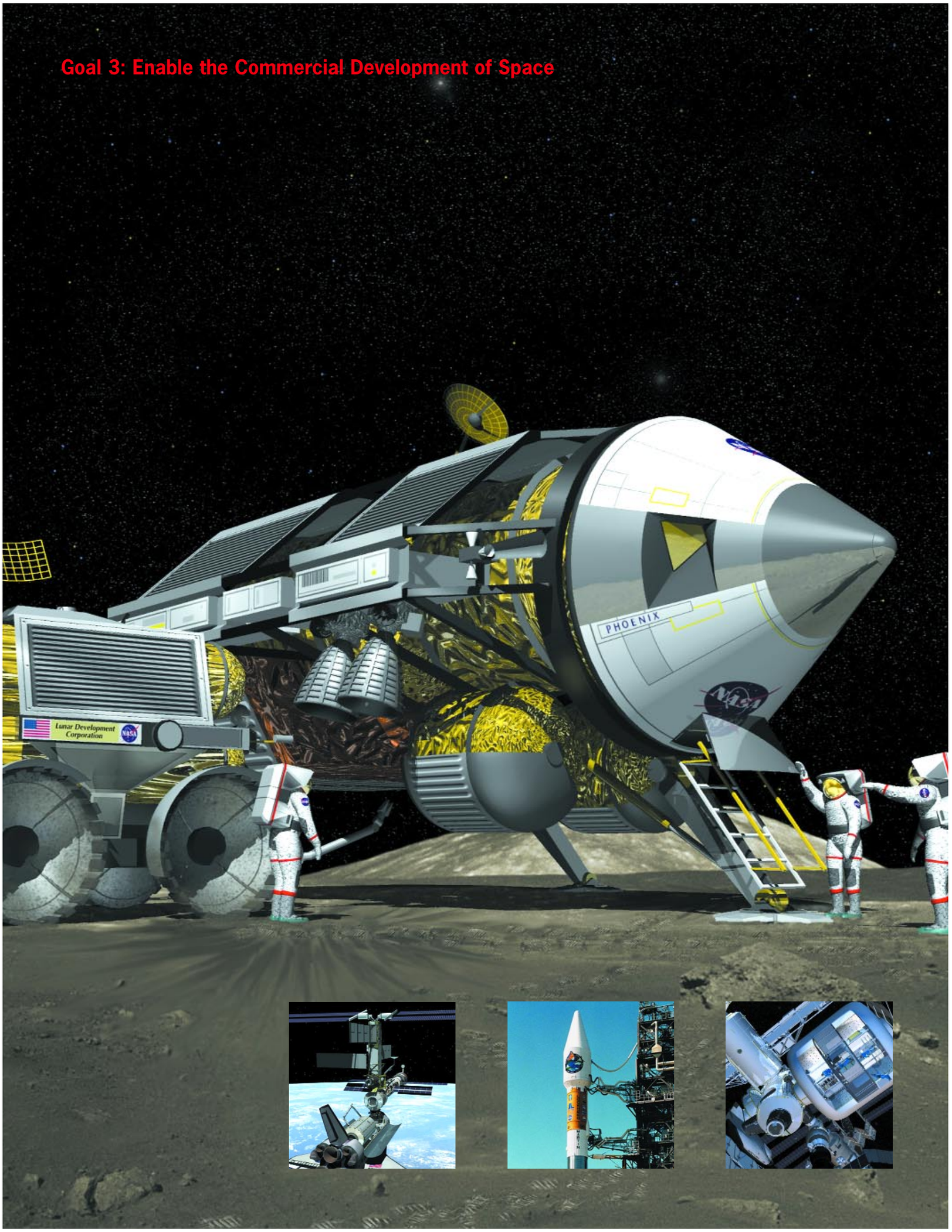
Mid-term (2006–2011)

- Continue to strengthen partnerships with Space Shuttle contractors and industry to ensure Space Station access and to provide for Space Shuttle upgrades until a viable replacement launch vehicle is available.
- Partner within NASA and with industry to complete technology needed for future HEDS space transport.
- Buy commercial communication services for initial 100-day class human missions.
- Undertake pilot efforts to commercialize the International Space Station operations, reducing costs while improving safety and productivity.
- Initiate Government-commercial partnerships in research and development, and introduce new technologies to extend the Station life beyond 2012, or as needed.
- Conduct full-scale scientific, exploration, and engineering research on the Space Station; enable commercial research on the International Space Station via the non-governmental organization.
- Partner with industry to build a first-generation, advanced in-space transportation system capable of meeting both commercial and 100-day human mission needs, while reducing costs by a factor of three versus 1990's systems.
- Implement countermeasures for space radiation and microgravity environment.
- Test and validate technologies and systems that can reduce the overall mass of the human support system by a factor of three compared to 1990's levels.
- Complete research and technology validation (including demonstrations on the Station) of competing technologies for 100- to 1,000-day class human missions.
- Develop space communications technologies such as optical communications for 500- to 1,000-day class human missions.

Far-term (2012+)

- Partner with industry to reduce HEDS Enterprise space transportation costs more than 80% while ensuring safety by building the following:
  - A next generation launch capability from spaceports on Earth able to meet **HEDS Mission** needs *(see page 1)*
  - Evolutionary in-space transportation systems and infrastructures capable of meeting commercial and human exploration mission needs
- Complete development of safe, self-sufficient, self-sustaining systems to enable humans to live and work in space and on other planets—independent of Earth-provided logistics—for extended periods.
- Complete the transition of International Space Station to a customer-driven commercial operation.
- Work with industry to identify and implement major upgrades as needed to extend Space Station life expectancy and/or expand its capability to meet user community needs while improving safety.
- Buy selected commercial communications services for initial 1,000-day human missions.
- Buy services from the International Space Station commercial operator to validate technologies for future human missions exceeding 1,000 days.
- Within NASA, integrate the use of human and robotic explorers to maximize results on both science and exploration missions.

Goal 3: Enable the Commercial Development of Space



Wherever humans go and wherever they live, there too is commerce.

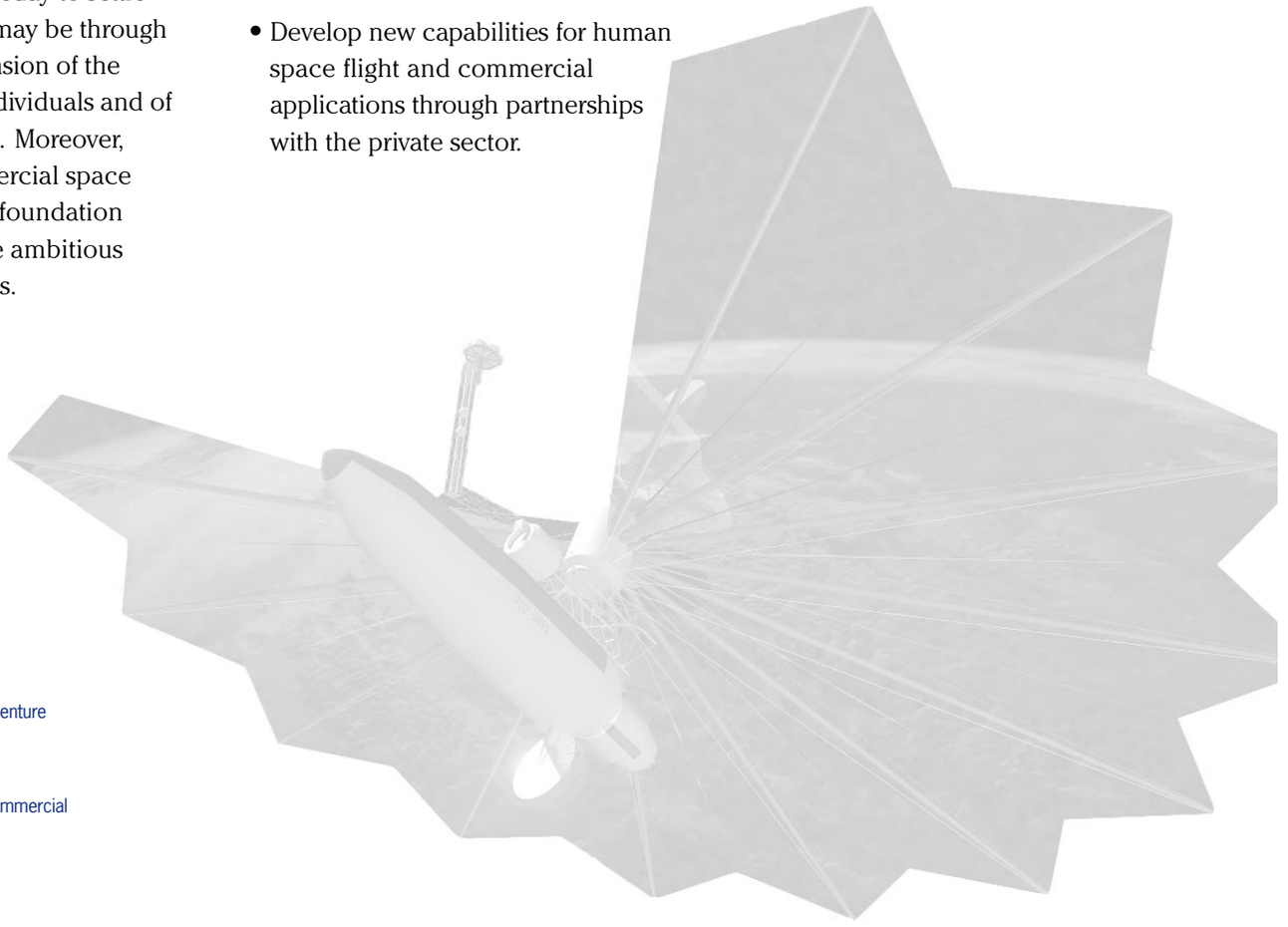
Commerce is essential to human society; free-market transactions are the foundation of the dramatic progress humankind has made during the past several centuries. Wherever humans go, they are certain to bring commerce with them, and space will be no exception. The free market will provide an effective mechanism for delivering tangible benefits from space back to American people.

If humanity is to explore and develop space to better exploit the space environment for profound scientific discoveries, and someday to settle the space frontier, it may be through the continuing expansion of the private sector—of individuals and of industry—into space. Moreover, enabling new commercial space activities will lay the foundation for subsequent, more ambitious exploration objectives.

As we open the space frontier, we must therefore seek to expand the free market into space. NASA is committed to enabling the commercial development of space.

Goal 3: Strategic Objectives

- Improve the accessibility of space to meet the needs of commercial research and development.
- Foster commercial endeavors with the International Space Station and other assets.
- Develop new capabilities for human space flight and commercial applications through partnerships with the private sector.



Captions:

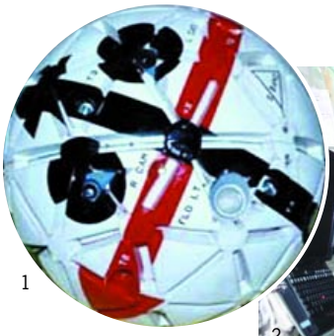
Commercial lunar exploration venture

Left: Commercial use of the International Space Station

Middle: Access to space by commercial expendable launch vehicles

Right: Commercially provided habitation module

Enable the Commercial Development of Space—Time-Phased Objectives Roadmap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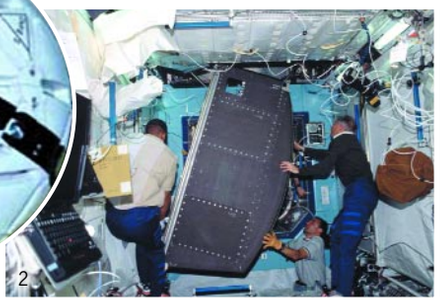
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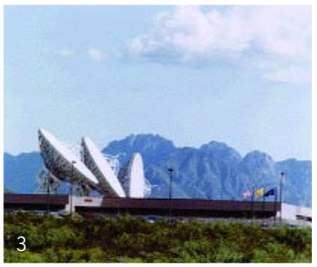
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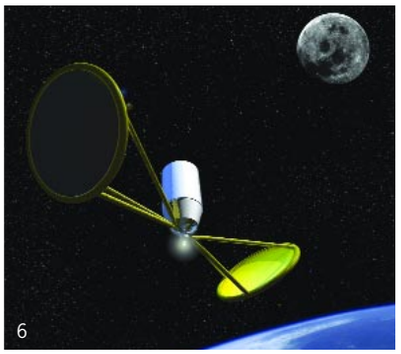
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Near-term (2000–2005)

- Pursue establishment of a non-governmental organization that, in partnership with NASA, provides non-government leadership for commercial endeavors on the International Space Station. The non-governmental organization will provide a simpler, more economical process by which private-sector organizations may apply for Station access. NASA will
  - make available for commercial use 30 percent of the U.S. share of the Space Station pressurized accommodations and 20 percent of the U.S. share of unpressurized payload accommodations; and
  - process commercial Space Station proposals in less than six months and negotiate them in less than three months, on average.
- Formulate and advocate policy, legislative, and engineering actions to facilitate privately funded commercial space development, including removing barriers and providing appropriate incentives.
- Foster the use of new commercially developed U.S. launch systems to provide safe, reliable, lower-cost access to space.
- Ensure that Agency investments in space launch and related technology stay focused on meeting Agency requirements and maximizing use of U.S. commercially developed products and services.
- Seek new approaches to collaborate with the private sector to develop future HEDS capabilities.
- Identify jointly with industry the commercial potential of candidate exploration concepts and technologies for 100-day human missions. Establish cooperative research and development projects to substantially reduce the Government cost of such missions.
- Replace the NASA ground stations that provide communications with low-Earth orbiting robotics missions with commercial and university-provided services, where practical and feasible.

Captions:

1 Autonomous EVA Robotic Camera, AERCam Sprint

2 International Space Station crewmembers installing station rack in the Destiny module

3 Commercial communications facilities

4 & 5 Commercial experiments conducted in space

6 Commercial Solar Orbit Transfer Vehicle (SOTV)

7 Expendable launch vehicle, Pegasus

8 Commercial use of the completed International Space Station

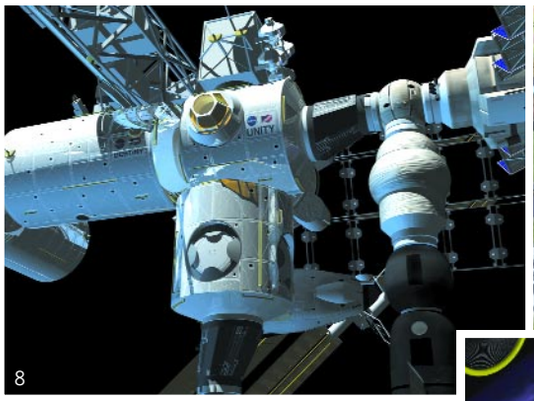
9 Propellant depots in space enable satellite servicing and more efficient space transportation

10 Commercial development of space with a space business park providing lodging and entertainment

11 Future commercial spaceport

12 Space Solar Power collects solar energy and beams it to Earth for conversion to electrical power

13 Space elevator transfers passengers from Earth to a facility in geostationary orbit, circa 2050+



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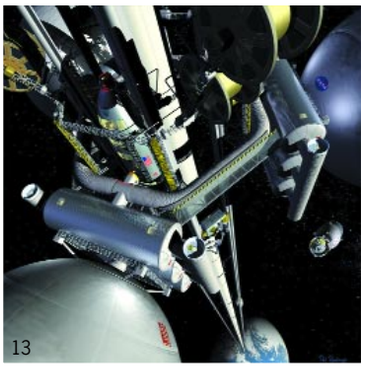
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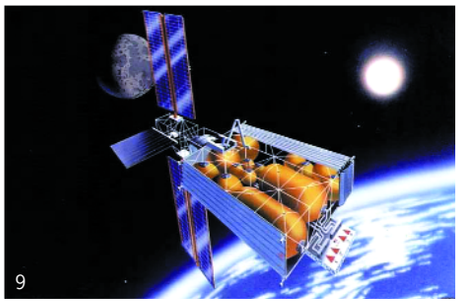
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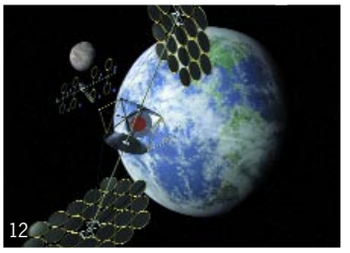
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Mid-term (2006–2011)

- Offer the International Space Station as a commercial research and development test-bed with the goal of a greater than 3:1 ratio of private to public financing.
- Expand Station operations to permit regular docking of commercial transportation systems and space platforms.
- Reduce public subsidies to private enterprises on the Station.
- Refine and implement policy, legislative, and engineering actions to make possible a privately developed, launched, and operated self-sustaining infrastructure that co-orbits with the Space Station and employs the Station principally as a service center. This will greatly expand private-sector low-Earth orbit operations.
- Identify jointly with industry the commercial potential of various concepts for 1,000-day human exploration missions and establish cooperative research and development projects to develop the candidate technologies.
- Transfer spaceport and range technologies to the commercial sector to stimulate commercial spaceport and range development.

Far-term (2012+)

- Double the International Space Station accommodations available for commercial ventures compared to the mid-term.
- Complete the transition of the Station from public to private and fully transform the Government role from sole operator to customer. The Space Station will now be commercially operated on a fee-for-service basis as a scientific laboratory, technology test bed, and business venue. All customers will pay market-based prices.

Goal 4: Share the Experience and Benefits of Discovery

Every American should have the opportunity to share in the experience and benefits of space exploration and development.

Americans—of all backgrounds—should have the opportunity to share in the experience and benefits of space exploration and development. During the past four decades, ambitious human space flight missions have inspired generations of young people to undertake careers in science, mathematics, and engineering, benefiting both themselves and society. The space program can enrich society by directly enhancing the quality of education.

Terrestrial applications of technologies developed for space have saved many lives, made possible medical breakthroughs, created countless jobs, and yielded other tangible benefits for Americans. The further commercial development of space will result in still more jobs, technologies, and capabilities to benefit people the world over in their everyday lives.

NASA is proud to share the experience, the excitement, and the benefits of human space flight with all humankind.

Goal 4: Strategic Objectives

- Engage and involve the public in the excitement and the benefits of—and in setting the goals for—the exploration and development of space.
- Provide significantly more value to significantly more people through exploration and space development efforts.
- Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

Captions:

Students participate in a space studies program

Left: Kids try out a space glovebox at a NASA Open House event

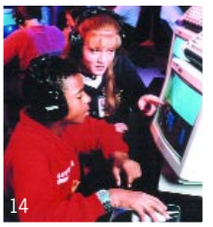
Middle: Space Shuttle exhibit featuring the upgraded cockpit

Right: The public learns about the high-powered microscope used in space experiments

Share the Experience and Benefits of Discovery—Time-Phased Objectives Roadmap

Near-term (2000–2005)

- Put into operation "Human Exploration and Development of Space: Education Implementation Plan" that builds upon four cornerstone principles: customer focus, collaboration, diversity, and evaluation. The plan guides HEDS efforts to communicate broadly the new knowledge, breakthrough technologies and innovative capabilities associated with various prospective HEDS Enterprise education activities.
- Expand public access to HEDS mission information (especially the International Space Station) by working with industry to create media projects and public engagement initiatives that allow "first-hand" public participation using telepresence for current missions, and virtual reality or mock-ups for future missions beyond Earth orbit.
- Provide appropriate NASA support for broad industrial development in space, including public space travel, in the context of increasing commercialization of space operations and development.
- Build partnerships with educators at all levels, from K–12 through colleges and universities (including minority colleges, universities, and similar institutions), in order to
  - increase the involvement of faculty and students in establishing HEDS goals and objectives;
  - enable "first-hand" interactive participation in both human and robotic exploration;
  - make exploration a part of new science curricula; and
  - create a diverse pool of scientifically capable graduates.
- Analyze and translate HEDS research and technology results to support curriculum and professional development standards for the K–12 education community.
- Use HEDS unique mission to encourage K–12 teachers and students to improve science literacy and to incorporate science, mathematics, technology, and engineering into coursework. Education programs will emphasize teacher preparation and the participation of underrepresented groups.
- Prepare the next generation of researchers through programs focused on undergraduate and graduate students in science and engineering programs (particularly underrepresented groups), increasing the opportunity for "hands-on" experience in HEDS-related disciplines.
- Seek opportunities with informal educational institutions (e.g., museums) to use HEDS and related science results and products in order to foster the development of an informed and aware public.
- Work with college and university faculty and students in conducting HEDS research and technology for future exploration.
- Ensure that HEDS programs and initiatives work to fulfill NASA's educational goals.



Mid-term (2006–2011)

- Continue human exploration customer engagement initiatives that allow "first-hand" participation in HEDS missions beyond Earth orbit, including both robotic "outpost" activities and 100-day class human expeditions being studied or implemented, using telepresence, virtual reality, or mock-ups, as appropriate.
- Strengthen and expand partnerships with K–12 schools, colleges, and universities (including minority colleges, universities, and similar institutions), in order to
  - continue student involvement in establishing HEDS Enterprise goals and objectives;
  - broaden "first-hand" interactive participation in exploration, including developing "outposts" and 100-day class human missions;
  - continue to help educators include exploration in new science curricula; and
  - expand the pool of capable and diverse graduates in the 2010+ timeframe.
- Strengthen and expand relationships with colleges and universities in the implementation of HEDS R&T.
- Expand education opportunities with K–12 teachers and students, as well as informal education institutions, by exploiting the new knowledge, new technologies, and discoveries from the International Space Station, from collaborative robotic missions, and from the first human missions beyond Earth orbit to inspire students to pursue science and technology curricula.

Far-term (2012+)

- Expand public engagement through continuing initiatives that allow meaningful participation in ongoing or planned HEDS missions beyond Earth orbit—including both robotic "outpost" activities and 100- to 1,000-day class human expeditions.
- Retarget HEDS academic research and exchange programs to focus on integrated human-robotic exploration missions.
- Update HEDS education programs to exploit the most recent discoveries from human and/or robotic exploration missions to inspire students to pursue science and technology curricula.

Captions:

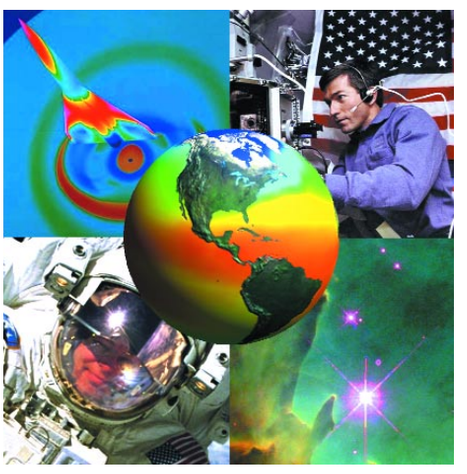
1 Safety awareness at NASA Open House
2 Promote "hands-on" experience for college students, tether satellite experiment (ProSEDS)
3 Technology commercialization exhibit
4 Spacesuit exhibit, NASA Open House
5 & 6 Space suits designed by NASA for children suffering from rare genetic disorders (For more information on the charitable organization that provides these garments go to: http://www.hedfoundation.org)
7 Students from Cocoa, FL watch the launch of mission STS-100
8 Winners in the college division of the 2001 Great Moonbuggy Race in Huntsville, AL
9 NASA technician wearing a Flight Suit, NASA Open House
10 Education Outreach space studies program
11 Students assemble components to demonstrate electrodynamic propulsion
12 Mission Control at Space Camp
13 An astronaut on the Space Station communicates with a student on Earth
14 Flight simulator at Space Camp

Implementing Strategies

The following implementation strategies will create a foundation for the success of the strategic goals and objectives described earlier:

- Ensure that safety and health are inherent in all that we undertake.
- Pursue continuing improvements in program and project management practices and tools.
- Engage customers in setting HEDS goals and objectives.
- Employ open, competitive processes for selecting research and technology projects.
- Promote synergy within and among NASA Centers.
- Promote synergy among research disciplines and between research and flight activities, both within HEDS and with other Enterprises.
- Ensure continued excellence in workforce staffing.
- Use new capabilities to create, capture, and manage knowledge.
- Develop and use collaborative and other new engineering tools.
- Forge partnerships and customer engagement alliances across a broad spectrum, including the following:
  - Academia
  - Industry
    - Aerospace
    - Non-aerospace (e.g., engineering, information technology, health care, biotechnology, electronics)
  - Other NASA Enterprises, including the following:
    - Aerospace Technology
    - Biological and Physical Research
    - Earth Science
    - Space Science
  - Other organizations, including the following:
    - International space agencies and organizations
    - Other U.S. Government agencies
    - Nonprofit and non-governmental agencies.

NASA Benefits: Create education excellence, promote economic growth and security, protect the environment, increase understanding of science and technology, and advance peaceful exploration and discovery.

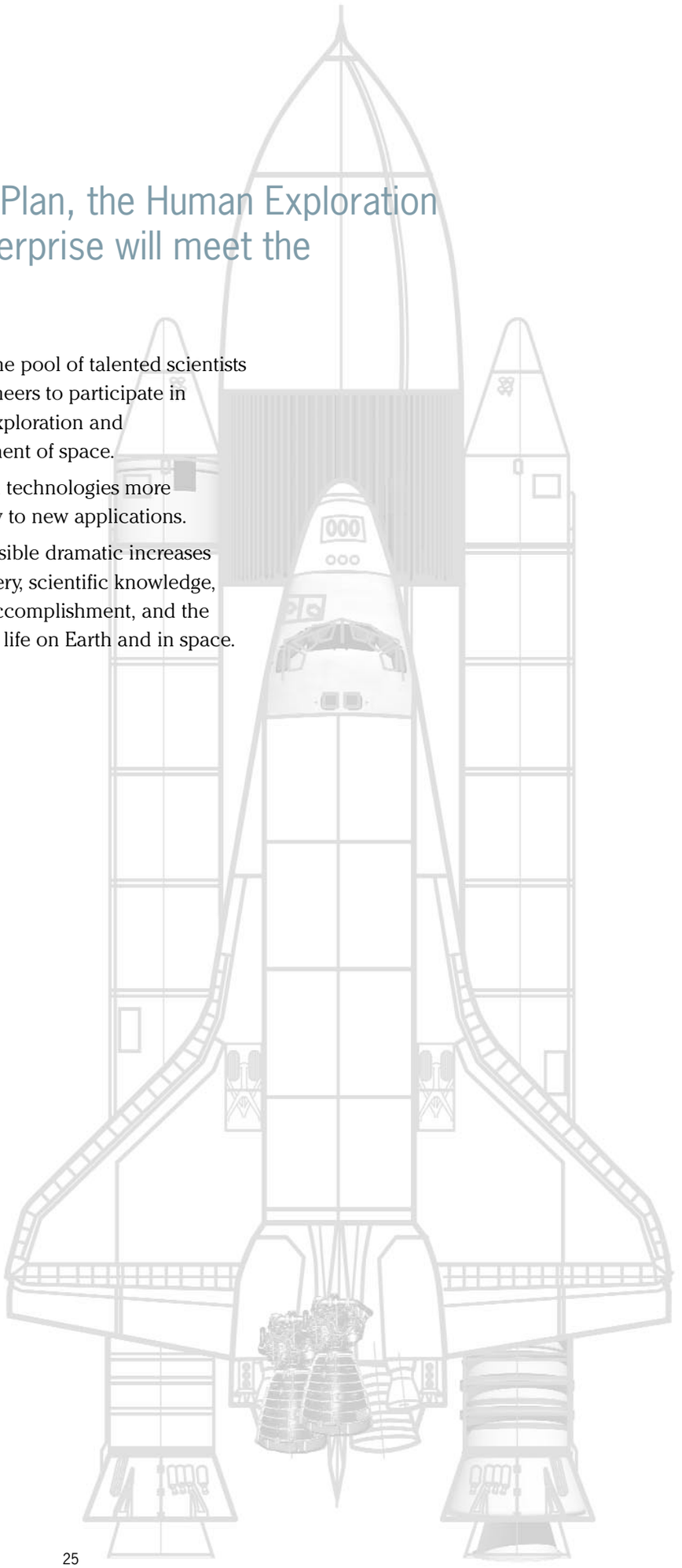


NASA Enterprises serve primary customers in science, education, commerce, public policy, and in other Government agencies.

Challenges

By implementing this Strategic Plan, the Human Exploration and Development of Space Enterprise will meet the following challenges:

- Reduce costs of human access to and operations in space.
- Reduce transit times and dependence on Earth.
- Improve opportunities for scientific return.
- Commercialize routine space operations.
- Increase opportunities for the private sector to participate in and provide services to Government missions.
- Collaborate on pioneering robotic missions to collect data, demonstrate technologies, and establish "outposts" of continuing operations.
- Inspire the public and seek their participation in defining HEDS future goals and objectives.
- Improve public access to near-real-time information from enhanced, more varied sources.
- Enlarge the pool of talented scientists and engineers to participate in human exploration and development of space.
- Transition technologies more effectively to new applications.
- Make possible dramatic increases in discovery, scientific knowledge, human accomplishment, and the quality of life on Earth and in space.



Where Will This Plan Take Us?

During the coming 25 years, NASA hopes to achieve truly profound goals in space.

In so doing, we can make possible the permanent extension of human presence beyond the bounds of Earth and enable historic improvements in the quality of life and in our understanding of the solar system and the universe.

By implementing this Strategic Plan, the Human Exploration and Development of Space Enterprise can answer **The HEDS Challenge**. *(see page 4)*

NASA will accomplish the following:

- Continue to fly the Space Shuttle safely during its transition to customer-focused privatized operations, with upgrades to assure continuing improvements in safety, reliability and cost until a viable replacement vehicle is available.
- Complete International Space Station development, creating a new, unprecedented research laboratory, and transition the Station to totally customer-driven commercial operations.
- Define breakthrough concepts for affordable human exploration missions.
- Conduct collaborative robotic missions that lead the way in collecting data, demonstrating technologies, and setting in place continuing operations at key sites (i.e., "outposts").
- Pursue exploration technology research and development through NASA/industry partnerships, while further partnering with industry to enable human exploration and commercial space goals to support one another through the development of important new capabilities that can meet both needs.
- Transform NASA's relationship with students, faculty, industry, and the public by engaging them broadly in setting goals for the human exploration and development of space.
- Make possible dramatic increases in discovery, scientific knowledge, and human accomplishment through U.S.-led international partnerships to develop the capabilities needed to implement
  - 100-day class human exploration missions (i.e., within the near-Earth region) during the mid-term;
  - 1,000-day class human exploration missions (i.e., within approximately two astronomical units of the Sun) during the far-term; and
  - 2,000-day and longer missions with humans to destinations in the outer solar system.

What Do You Think?

The HEDS Enterprise is committed to engaging its customers in the formulation of strategic goals, objectives, and future program directions. To begin that process, NASA invites comments from any interested reader of this plan. The Enterprise will review all input and consider it for inclusion in a future update of this plan.

Please direct all comments and suggestions to the following e-mail address:

heds-strategic-feedback@hq.nasa.gov

For further information detailing the Human Exploration and Development of Space Enterprise, please visit our website at:
http://spaceflight.nasa.gov

Astronaut Thomas Jones, STS-98 mission specialist, working outside of the International Space Station

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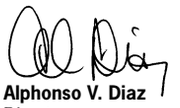

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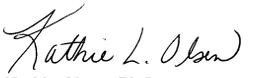

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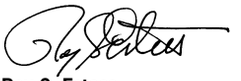

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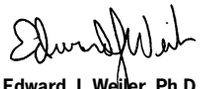

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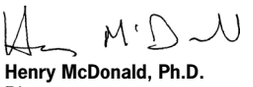

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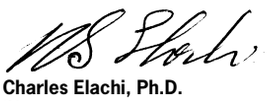

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National Aeronautics and Space Administration

Human Exploration and Development of Space Enterprise

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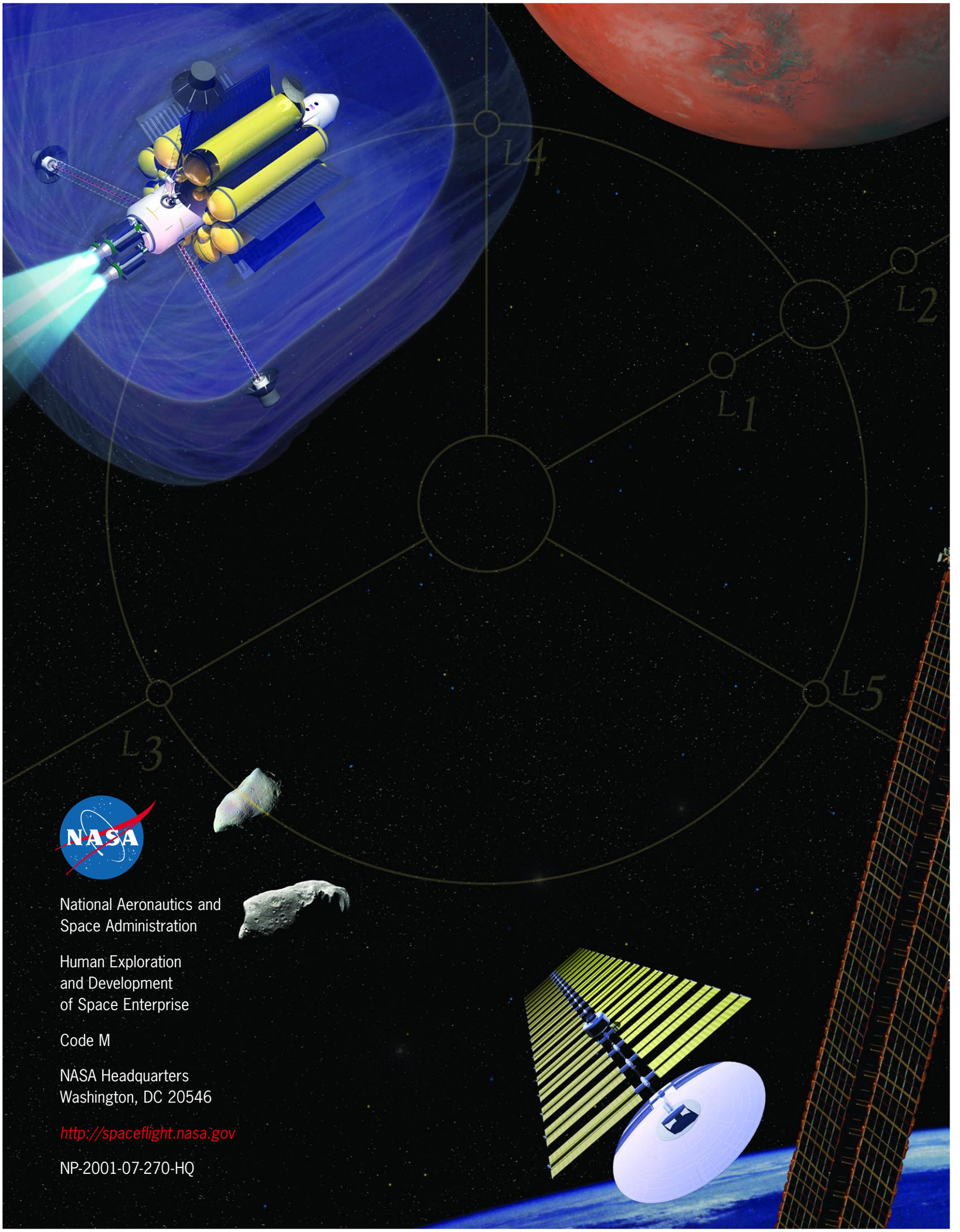

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